

# KEEPING THEM INVOLVED - ENCOURAGING AND MONITORING STUDENT ACTIVITY

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## ***ABSTRACT***

*In the teaching of engineering, lecture classes are often essentially expository with students in a passive role, not preparing learners for autonomous work and this may contribute to high failure and attrition rates. One way to combat this is through the application of Active Learning (AL) methodologies. In this paper results are presented from the application of an AL Methodology in the classroom and outside it for a last year subject of a BEng degree. A Learner Activity Monitoring Matrix has been used to monitoring in-class learner activity. Also described is the implementation of AL outside class using an online learner management system (LMS) which permits voting by students on the quality of solutions proposed by their peers to resolve engineering problems posed by the lecturer. Empirical data regarding the online participation in the process of each learner is provided. A pre-post survey to reveal student perceptions regarding these methodologies is also presented.*

**Key words:** *Active learning, peer-voting, LAMM, online LMS*

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# 1 INTRODUCTION

## 1.1 Background

Since the appearance in 1988 of Felder's paper on Learning and Teaching Styles in Engineering Education (Felder and Silverman, 1988) which concluded that there was a mismatch between most engineering education and the learning styles of most engineering students, there has been an increasing interest in developing teaching techniques to address all learning styles with a particular emphasis on the importance of active learning supported by pedagogies of engagement, often involving a cooperative or problem-based approach, with the aim of improving the outcome of Engineering Education in Europe, the US and Asia.

Felder carried out a longitudinal study following the effect of active and cooperative techniques designed to address a broad spectrum of learning styles on a cohort of students over 5 semesters (Felder et al., 1998) and found that an experimental group using these techniques in chemical engineering subjects outperformed a comparison group on a number of measures, including retention and graduation, and many more of the graduates in this group chose to pursue advanced study in field. He also notes that academic performance in other course subjects was better in the groups studied. Other authors have carried out meta-studies which present an accumulation of evidence for the effectiveness of active and cooperative learning in engineering education (Johnson et al; 1991; Prince 2004).

In addition to the engineering educationalists referred to above, there have also been related studies in a number of other fields: Paulson (1999) reported significant improvement in pass rates on applying active and cooperative learning in a chemistry course while Michael (2006) in a combative paper entitled "Where's the evidence that active learning works?" presents results across a broad range of scientific teaching communities. Michael's paper also succinctly presents the case for scientists to adopt an evidence-based approach to education and training:

"As scientists, we would never think of writing a grant proposal without a thorough knowledge of the relevant literature, nor would we go into the laboratory to actually do an experiment without knowing about the most current methodologies being employed in the field. Yet, all too often, when we go into the classroom to teach, we assume that nothing more than our expert knowledge of the discipline and our accumulated experiences as students and teachers are required to be a competent teacher. But this makes no more sense in the classroom than it would in the laboratory! The time has come for all of us to practice "evidence-based" teaching."

## 1.2 Active Learning

The work reported here is guided by the social constructivist view of learning which advocates understanding the fabric of interaction that has emerged over time through reciprocal roles played by actors (Berger & Luckmann, 1966) and thus sees activity and engagement of higher education students as playing a key part in their learning processes.

"Learning is not a spectator sport. Students do not learn much just sitting in classes listening to teachers, memorizing pre-packaged assignments, and spitting out answers. They must talk about what they are learning, write reflectively about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves" (Chickering and Gamson, 1987). Active Learning has been defined as any strategy "that involves students in doing things and thinking about the things they are doing" (Bonwell and Eison, 1991) and this broad definition can be taken to include

a very wide range of teaching and learning activities including collaborative and problem-based learning. In this work, however, we follow Paulson (Paulson and Faust) in using the term more narrowly to refer to a number of techniques that can be incorporated in the lecture context so as to give students a more active role in their learning process.

### **1.3 Context**

The academic year 2006/07 was the first year in which new ministry-approved Bologna Process courses were run in Portuguese higher education institutions. In the teaching of engineering in Portugal, the classes are traditionally classified into theoretical and practical. The theoretical classes are devoted to transmission of the concepts needed to solve problems students will work on in practical classes. Thus, the lectures are often essentially expository with students in a passive role (Cox 2008, Williams and Carvalho 2010).

One way to combat the high failure and attrition rates is through the application of Active Learning methodologies. The application of active learning in the classroom encourages student engagement through greater involvement in what is being taught. The application of this approach can also promote autonomous work outside class by extending active learning beyond the lesson period. Thus, it is also possible to consolidate the teaching program content with greater availability of time for classroom activities. The active learning methodologies implementation described here were implemented in a Structural Concrete course unit (4 hours per week). This is a one-semester subject of the third (last) year degree course leading to a Portuguese Licenciatura (B Eng) in Civil Engineering. A Learner Activity Monitoring Matrix (LAMM), which the authors of this study are involved in developing, was used for classroom observation.

## **2 RESEARCH QUESTIONS**

As mentioned above, several authors noticed that the learning is more effective if students adopt an active role. Thus, the main research questions formulated are:

- (i) Can the application of AL strategies place students in an active role in lecture-type classes in the Portuguese engineering education context?
- (ii) Can a Learning Management System like Model be effective in encouraging student engagement outside class using an online environment?

## **3 ACTIVITY IMPLEMENTATION AND RESULTS IN THE CLASSROOM**

Several in-class activities from two online activity banks (Paulson and Faust; Felder and Brent, 2006) containing around 30 different activities found to be useful in engineering courses in the United States, were adapted for use in this course unit. From these lists a few activities were selected to be used in a variety of course contents, namely: In-Class Teams; Think-Pair-Share; Minute paper; Regular uses of students' names; The "One Minute Paper"; Muddiest (or Clearest) Point; Affective Response; Clarification Pauses; Wait Time; Discussion; show of hands voting; active review sessions, and student revision lists. Following Felder's recommendation to "go for variety" (Felder and Brent, 2003) the strategy adopted was one of interspersing more traditional exposition with a number of short learner activities, answering questions, solving problems, brainstorming, etc. and bearing in mind his maxim that "mixing things up keeps active learning from becoming as stale as straight

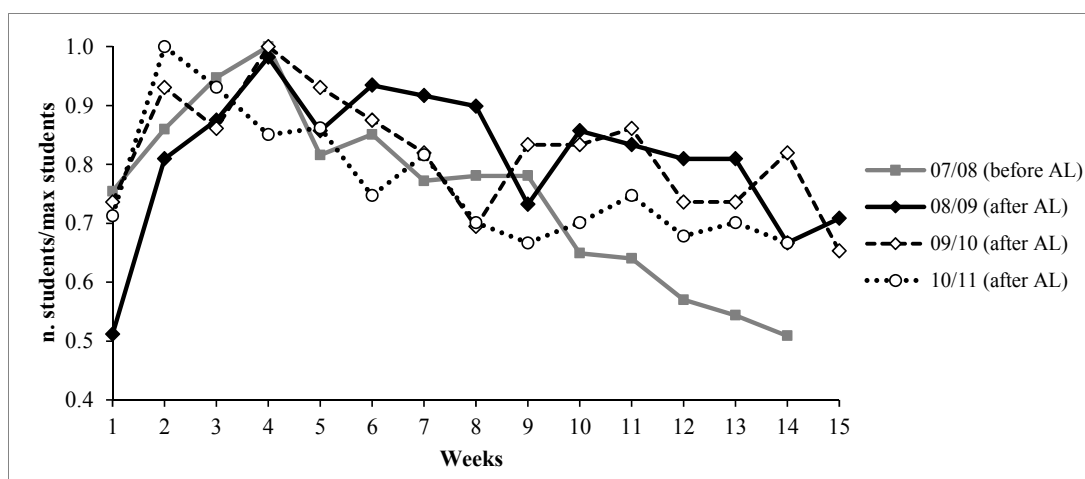


Overall, the lecturer's perception of increased learner activity and engagement over the period under study is clearly reflected in the semi-quantitative data obtained from the LAMM-registered observations.

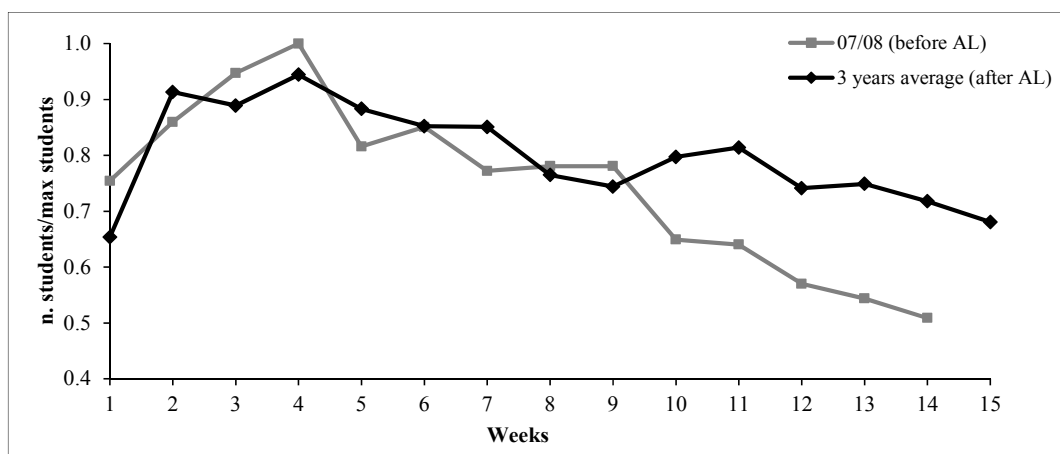
**Table 1. LAMM results before (i and ii) and after (1 to 17) Active Learning activities**

Observations	i	ii	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Activity Index	30	30	44	30	38	35	35	31	35	31	48	66	35	53	68	48	34	54	45
Participation Parameter	-	-	-	-	-	-	-	-	-	-	-	-	-	18.5	11.5	11.5	24	23	6.5

When attendance data, shown in Figures 2 and 3, for students enrolled in the Structural Concrete course unit from 2008/09 to 20010/11 is compared with students enrolled in the previous year of 2007/08 (same lecturer) there are clear similar patterns over the semester. However there is less of a decline in the final weeks in those where AL techniques were introduced.



**Figure 2. Semester attendance with (2008/2009, 2009/2010 and 2010/2011) and without (2007/2008) application of Active Learning methodologies.**



**Figure 3. Semester average attendance with and without introduction of Active Learning methodologies.**

Although these initial results represent a relatively small population of 225 students, around 75 per cohort, it is interesting to see that they reflect findings from other studies involving Active Learning and Audience Response Systems (clickers) which reported improvements in attendance when student activity in lectures was recorded by clicker responses (although only in cases where this activity contributed to more than 5% of the final grade) (Caldwell, 2007).

### 3.1 Engagement outside the classroom

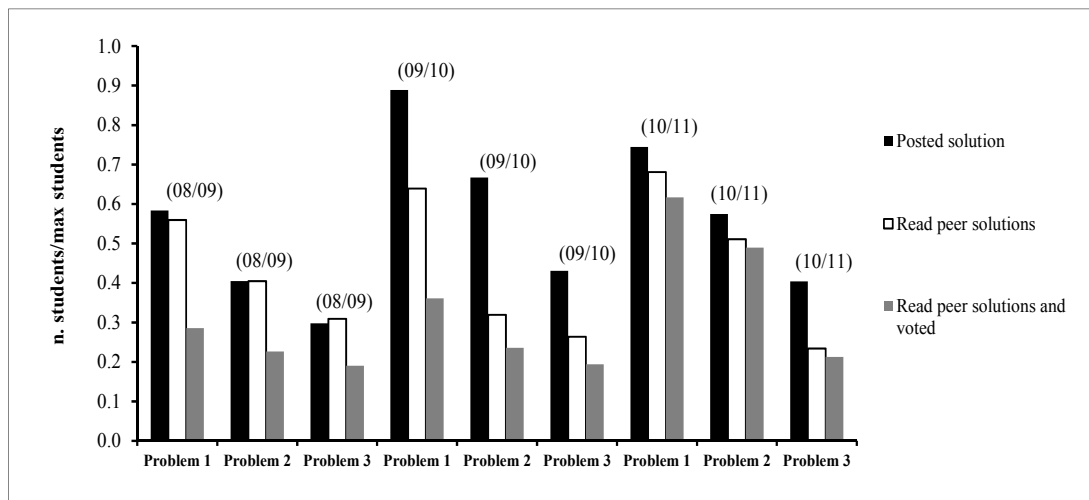
The evaluation methods for the course unit are common for various lecturers and are mainly summarised with a written exam predominating in determination of the final grades. From the analysis of the exams results of previous years, it was noted that students often had difficulty when confronted with applications of learned procedures in less familiar contexts. It was felt that there was a need for additional practice in solving conceptual problems. Accordingly Moodle was used to provide learners with additional practice in problem solving and allow them more flexible time management.

The Moodle survey function allows one to increase learner engagement with the material under study by introducing a peer voting process. This is essentially an online application of what Paulson refers to as Active Review Sessions (Paulson and Faust) – “In the traditional class review session the students ask questions and the instructor answers them. Students spend their time copying down answers rather than thinking about the material. In an active review session the instructor poses questions and the students work on them in groups. Then students are asked to show their solutions to the whole group and discuss any differences among solutions proposed”. The online asynchronous implementation has the additional advantage that it allows more time for learner reflection than conventional review.

A three-stage procedure was applied:

- Stage 1: Individual problem solving - students were given a statement online and had a week to post a justified comment to that statement. Once students post their answer they can see those of others. The solutions remain online but cannot be altered;
- Stage 2: Peer Selection – Individual critical analysis - students are allowed a week to vote for the best solution posted;
- Stage 3: Completion – the lecturer comments on the winning solution and gives a Moodle answer. A symbolic prize may be awarded to the most successful contribution.

Figure 4 shows the level of participation from students for the different problems posted online as the semester advanced along with the class attendance levels. We note a similar participation pattern in the three cohorts. Although the majority of the students were involved in solving Problem 1, there was a gradual fall in participation along the semester.



**Figure 4. Level of participation.**

Figure 4 also allows comparison of the Problem Solving and the Peer Selection stages. The data collected allow us to monitor the process and helps the facilitation of the procedure. In 2010/2011, overall, the number of students engaged in all stages was globally higher compared with the previous years. Although this was not analysed systematically, anecdotal evidence suggests that the decrease of online problem solving over time (as well as class attendance) is likely to be related to external factors like tests and assessed assignment deadlines for other course units. When comparing with the attendance registered in 2007/2008, this procedure seems to contribute towards keeping more of students engaged until the end of the semester. As an example, in 2010/2011 the presented procedure was introduced on the eighth week, which seemed to have a favourable contribution to the attendance stabilization for the last weeks of the semester, as we can see from Figure 2. When attendance data, shown in Figures 2 and 3, for students enrolled in the Structural Concrete course unit from 2008/09 to 2010/11 is compared with students enrolled in the previous year of 2007/08 (same lecturer) there are clear similar patterns over the semester. However there is less of a drop-off in attendance in the final weeks when the AL techniques were introduced.

### 3.2 Pre/post test of student perceptions of in-class activity

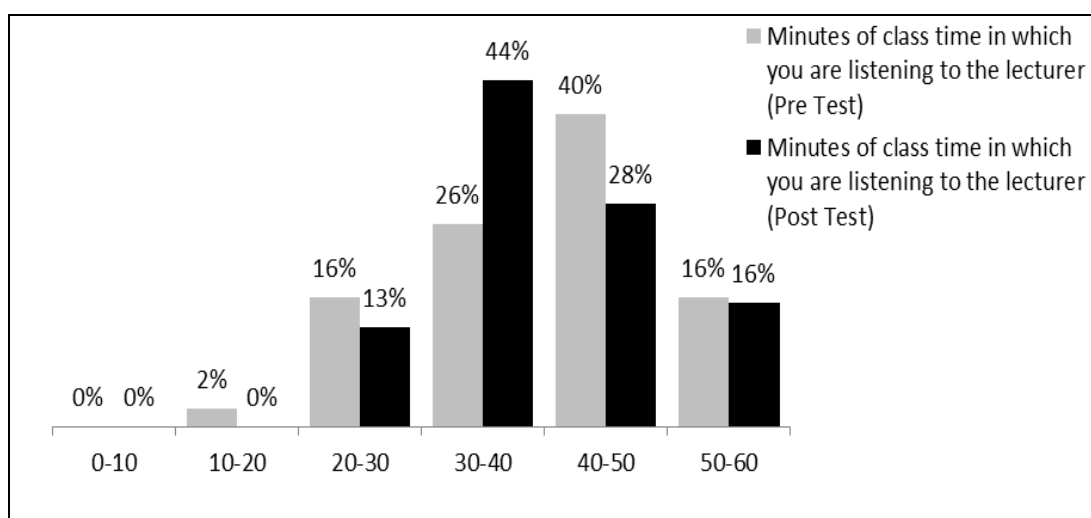
At the end of the semester the students of Structural Concrete completed a questionnaire containing the question “How would you describe what happens in this class to a colleague who will be doing the subject next year?” concerning the average amount of class time devoted to student activity when compared with time spent “just listening to the teacher” in the classes they attended. For comparison a cohort of students from the previous year were asked the same questions about what they anticipated for the course unit on arriving in the third year. From the results in Figures 5 and 6 it can be noted that the perceptions of the students who had completed the unit tend to support the data captured in the LAMM and exceed somewhat the expectation of those in the previous year. The student’s answers concerning the time involved in individual activities and group activities allow one to estimate a corresponding value of the Activity Index (Carvalho and Williams, 2009).

### 3.3 Procedure:

For simplicity in the pre-test questionnaire, no distinction was made between pair or group student activity and the same format was then applied to the post-test survey. In order to compare the student

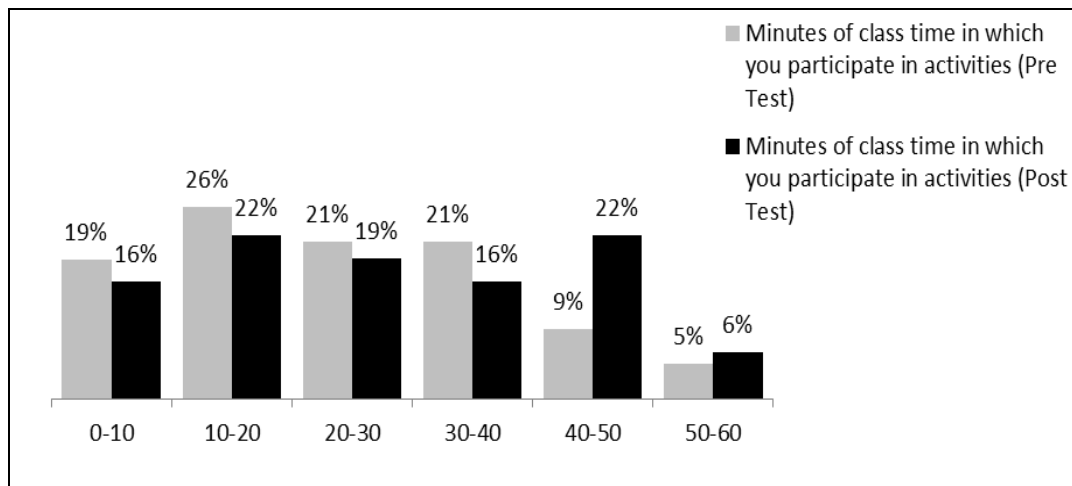
questionnaire responses with the Activity Index measured by the LAMM, a hypothetical AI value was calculated from the answers collected from the student questionnaires as follows: assuming a sixty minute lecture period, the equivalent number of observations for each type of learning situation was estimated. The maximum number of observations, which is 30, was taken into account and a weighted average was applied. Finally, the Activity Index formula, presented in the LAMM, was applied considering a weight of 1 for “listening the lecture” and an average value of 2.5 (between 2 and 3) for “participating in activities”. In this way, average times of 18 minutes and 22 minutes were obtained for time involved in individual activities and group activities, respectively. Thus, by application of the Activity Index calculation formula as before, a value of 49 is obtained for the post-test questionnaire while the pre-test value was 47.6. The value for the learners’ perception of their activity after completion of the unit exceeds the one obtained directly from LAMM observation data which give an average value of 43, based on the data presented in Table 1 (observations 1-17 after AL) which means that the observed time devoted to student activity in the lecture classes was actually lower than student expectation and student perception as measured by the questionnaires.

Incidentally, although second year students (Figures 5 and 6) anticipated a marginally more passive role in the subject than those who had completed the unit, it may be worth commenting that both anecdotal evidence and our initial data on lecture classes in the school would have led us to anticipate that students would expect a “theory class” to be almost 100% listening which was far from the case according to the 2nd year questionnaire results. It is not clear at this stage whether these results represent a Hawthorne Effect (Mayo, 1977) or are perhaps due to the fact that although only a minority of faculty are engaged in Active Learning teaching, it is having a larger effect on the school culture and student perception than was hitherto realized. This is an area for study in future iterations of the research.



**Figure 5. Comparison between Pre and Post Results. Minutes listening to the lecturer.**





**Figure 6. Comparison between Pre and Post Results. Minutes participating in activities.**

#### 4 DISCUSSION

The Activity Index values obtained indicate that the AL techniques employed in the lecture classes monitored in this study increased learner activity. Likewise the online peer voting process was seen to provide additional outside class practice to students than cohorts in previous. From a practical perspective, although both of these approaches provide relevant data in usable form and thus lend themselves to research on the efficacy of pedagogical interventions, it is worth noting that the peer-observation LAMM method does make more logistical demands in that it requires additional person-power to observe classes. By contrast, the LMS peer-voting procedure, once the set up and tested by the instructor, can be iterated relatively easily.

Obtaining credible quantitative data to measure the effect of teaching innovation on student test-scores and retention rates is generally accepted to be problematic when based on small samples like we are working with (Prince 2004; Wankat et al., 2002). Accordingly, it is not our aim to attempt to demonstrate unequivocally that AL techniques are as beneficial in the Portuguese engineering education context as they have been shown to be internationally in larger studies, because the generation of valid, credible data on aspects like student grades and attrition would imply a timescale, number of participating students and scale of project we are not in a position to undertake at this stage. Although there is no published work to date demonstrating the value of these techniques within the specific context of Portuguese engineering education, given the existence of a large and credible body of research, including longitudinal and meta-studies, showing their value in engineering education in other countries, particularly in the US (Felder et al., 1998; Paulson 1999; Prince 2004; Springer et al., 1998), we believe we can be confident of the qualitative benefits to student learning from employing these techniques in the Portuguese context to increase learner engagement because as has been argued in a previous paper, the available published data allow us to take learner activity as a proxy for learning in lecture classes.

#### 5 CONCLUSIONS

The initial results presented for the use of Active Learning techniques in lecture classes of a course unit in the final year of a civil engineering degree allied with the use of an online outside class learning environment (Moodle), suggest that this implementation brought about an increase in student

engagement as measured by the LAMM semi-quantitative observation system and a pre/post questionnaire of student perceptions. Initial results also suggest that this approach may lead to increased student attendance at lecture classes.

The LAMM observation system is currently in the process of validation to establish the consistency of Activity Index and Participation Parameters determination and to what extent it can distinguish between traditional and Active Learning centred teaching. The results reported suggest that it could represent a fruitful line of development to support engineering faculty members involved in the introduction of innovative pedagogical practice within a traditional lecture-based structure and the authors are currently developing this line of research within the broader framework of Technology Stewardship recently proposed by Etienne Wenger (Wenger et al 2009).

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